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THE CAROB IN CALIFORNIA

BY
I. J. CONDIT

NUTRITIVE VALUE OF THE CAROB BEAN

BY
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THE CAROB IN CALIFORNIA

By I. J. CONDIT

The carob, commonly known as St. John's bread, is native to the eastern shores of the Mediterranean Sea. From there it was taken by the Greeks into Greece and Italy, and later by the Arabs into northern Africa and Spain. The Spaniards took it to Mexico and to South America and the English to South Africa, Australia, and India. Although carob trees are grown along the whole Mediterranean coast, the great carob-producing regions of the Old World are Sicily, Cyprus, Malta, the southern half of Sardinia, and the Adriatic coast of southern Italy.

Probably the first introduction of the carob into the United States on any large scale was made from Spain in 1854 and from Palestine in 1859 by the United States Patent Office. According to the Report of the Patent Office for 1860, about 8000 plants were ready for distribution at that time. These were sent mostly to the middle and southern states, but some may have reached California.

About 1878 the California Agricultural Experiment Station propagated the plant and distributed seedlings during the next few years. According to Klee (1887), carob seeds were planted at Los Gatos in 1873 and a few of the seedlings bore fruit in 1885. One tree at the Shinn Nursery, at Niles, raised from seed sown on the spot in March, 1874, produced a few pods in 1884, only one tree out of several being a female tree. An excellent account of the history, methods of propagation, and uses of the carob is found in the report of the California Agricultural Experiment Station for 1884. The horticulturist reported in 1890 that "no tree distributed by the stations is more likely to make a popular shade and ornamental tree for dry, rocky situations." He further stated in 1895 that the carob is "fairly well adapted to resist alkali and its thick, firm leaves have but few equals in point of enduring the hot sun." At the Chico Forestry Substation a group of ten carob trees receiving no irrigation at any time, had lived through several winters, but nine out of the ten were killed in the spring of 1896.

In 1895 Dr. Franceschi of Santa Barbara stated that the carob had been much planted of late years and that there were several bearing trees in the neighborhood of Santa Barbara.

Cuttings and bud-sticks of the leading varieties of carob of the Old World have been imported by the Department of Agriculture since 1901 and distributed for trial. At the State Fruit Growers' Convention held at Fresno in 1912, Dr. Aaronsohn of Palestine called especial attention to the economic importance of the carob in other countries, stating that if we could observe what the people of his country do with the carob tree we would long ago have utilized this plant in California. C. W. Beers* until recently Horticultural Commissioner of Santa Barbara County, has done much during the past few years to arouse interest in the carob and has distributed thousands of seeds to prospective planters. With his coöperation, the value of carob pods for calf feed was tested at the University Farm, Davis, the results having been published in Bulletin 271 of this station.

BOTANY

The carob belongs to the legume family and is the only species of the genus, *Ceratonia* (from the Greek keronia, horn, in reference to the form of the pod). The specific name is *siliqua,* meaning pod. The carob tree is a handsome evergreen, 40 to 50 feet high, with large compound leaves, each bearing from one to six pairs of thick, leathery leaflets. The leaflets are sometimes alternate, although usually opposite with or without an odd leaflet at the tip.

The reddish or yellowish flowers are borne in lateral racemes, 1½ to 4 inches long, proceeding from the larger and older branches year after year, and forming eventually warty excrescences in the bark. The flowers appear from October to December although the blooming season may extend much later.

The majority of carob trees are dioecious, that is, have staminate or male flowers on one tree and pistillate or female flowers on a different tree. Occasionally trees are found which produce some perfect flowers in a cluster. In the staminate flowers the calyx-tube is disk-bearing, the segments of the disk being five in number and short. There are normally five stamens although six and seven are not uncommon. In the pistillate flowers the short, curved pistil proceeds from the center of the disk, the tip being enlarged and somewhat lobed. The perfect flowers have both pistil and stamens on the same disk.

The pistillate flowers after pollination develop into compressed, indehiscent pods, 4 to 10 inches long; these are thick and tough and

* The writer wishes to express his appreciation of the coöperation of Mr. Beers in collecting data for this bulletin, and especially for notes concerning propagation.

Fig. 1.—Pistillate racemes, pod, and typical leaf of the carob. The carob tree is a handsome evergreen with glossy, green, pinnate leaves. It is of ornamental value and is sometimes planted as a street tree in California. The pods are from four to twelve inches long, reddish brown in color, and contain a sweet pulp in which the hard, flattened seeds are imbedded. They form an important source of food, both for man and beast in the countries around the Mediterranean Sea.

filled with a sweet pulpy substance in which the flat, bony seeds are embedded. Before maturity the pods are astringent, due to the presence of tannin. The usual season for ripe pods is September and October, the pods remaining on the tree for weeks later if not gathered.

Fig. 2.—Staminate racemes of the carob. The carob tree is most commonly dioecious. In order to insure a crop of pods, growers in some of the European countries make a practice of grafting a staminate shoot in each pistillate tree. The individual flowers are discoid and bear normally five stamens, although the number varies considerably.

CLIMATIC AND SOIL REQUIREMENTS

The successful growth of old carob trees in various parts of the state from Imperial and San Diego counties in the south to Napa and Butte counties in the north is good evidence of their ability to thrive here. Many of the plants distributed by this station succumbed to the frosts of 1888 at Duarte, Healdsburg, and Marysville, and later experience has shown that the trees when young are no hardier than orange trees. When once established, however, the carob is more frost-resistant than the orange.* It is reported to have been uninjured

* The seedling carob trees along the highway west of Pomona showed considerable variation in frost resistance during the winter of 1918–19, some being killed entirely, others being uninjured.

at 18° F. at Santa Barbara. At Chico several varieties have survived temperatures of 18° to 22° F., while others have succumbed.

The carob tree is comparable to the loquat which blossoms and sets its fruit in midwinter. While mature specimens of either species may pass through the winter without a leaf or twig being injured, the annual production of fruit in any but the more protected localities is uncertain. Even if the blossoms escape injury from cold and rain, the developing fruit is liable to be killed by frost later on. For this reason the successful production of carob pods in the interior valleys is practically limited to the citrus belts along the foothills. The carob tree thrives in regions of intense heat, such as the Imperial and Coachella valleys where the winters are mild.

In southern Europe the carob is reported to thrive best in the vicinity of the sea. In California, however, it has been observed that trees near the coast do not fruit heavily, possibly due to the humidity factor. Although it is not, properly speaking, a native of arid regions, it is remarkably thrifty and productive in semi-arid countries such as Palestine. A well-drained soil is best suited to its development, but it has been found that young trees were not seriously affected by considerable soil moisture. While experience has shown that the carob will grow with less water than probably any common fruit tree, the olive not excepted, for best results it should be given a well-drained, moderately rich soil where some irrigation water may be provided.

PROPAGATION

Carob trees may be grown from cuttings, but as bottom heat and careful treatment are necessary, this method is seldom used.

Seedlings.—The most successful propagators remove the seeds from the pods, mix them with coarse sand and keep them moist in a glass house, or enclose them between layers of sterilized sacking or burlap.

The seeds which swell and show signs of growth are removed and planted in a propagating bed, composed of clay rolled and packed hard, upon which the seeds are placed and then covered lightly with sand and good soil to a depth of half an inch.

When the seedlings show two sets of leaves they are transferred to 2½-inch pots containing clay soil, the transplants being allowed to stand twenty-four hours without water, after which they are watered freely and kept in good thrifty growth. When about 5 or 6 inches in height they are transferred to 1-gallon tins or to boxes $6 \times 6 \times 8$ inches with a good potting soil. When the plants are from 3 to 5 feet in height they are ready for the orchard. By this method

a uniform growth is secured. It has been found that some seeds remain in the coarse sand for a year or more before starting.

The experiments of Dr. H. B. Frost, at the Citrus Experiment Station, Riverside, indicate that seed planted very quickly after maturing, and before the pod has become dry and hard, germinated quickly, grew thriftily, and the seedlings showed no evidence of damping off.

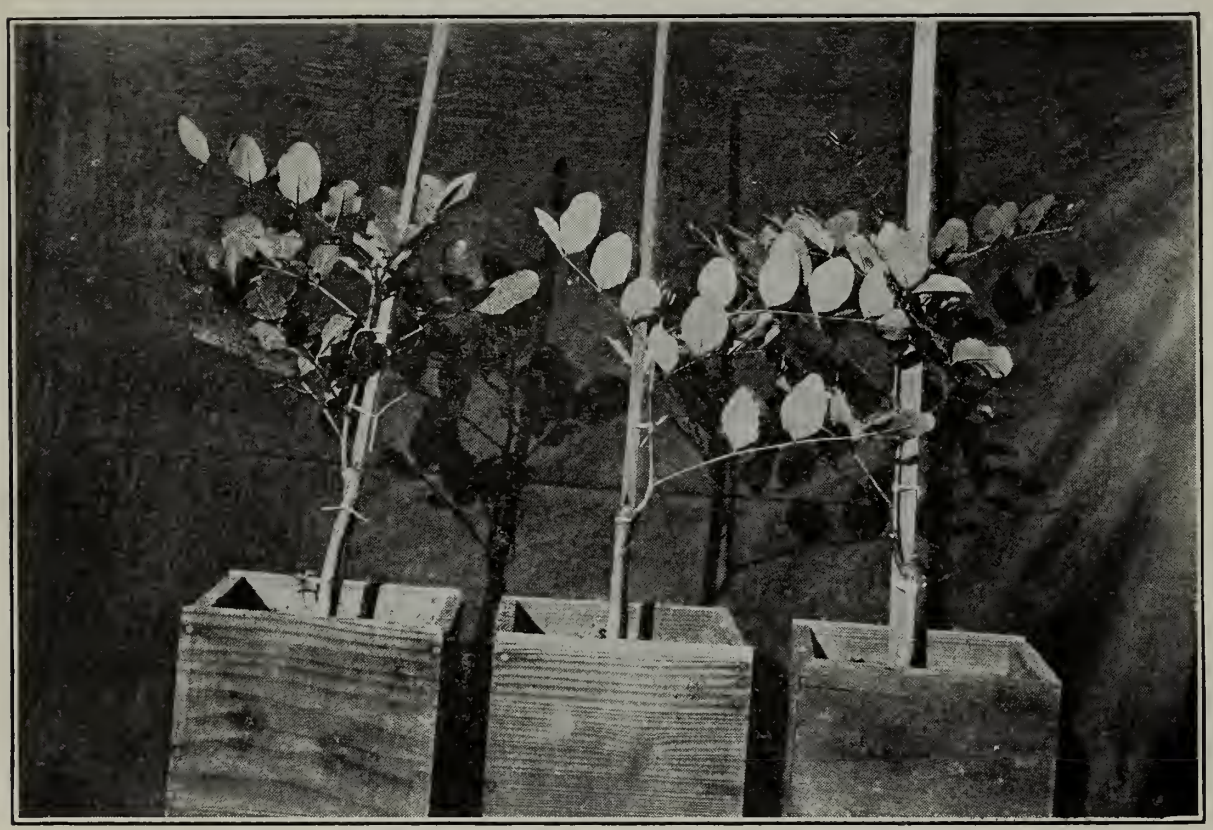

Fig. 3.—The propagation of the carob tree by budding is not an easy matter. Some budders, however, have had good success by placing spring buds in two-year-old seedlings grown in boxes. The buds grow rapidly when once started.

Seedlings planted in nursery rows develop a tap root three or four times as long as the top. The deep tap root makes transplanting difficult although the root may be shortened and lateral roots encouraged by running a cutter at the proper depth under the plants in the row. The plants in boxes may be budded or grafted successfully although the roots should not be allowed to become "pot-bound." Good success has been attained by planting the young seedlings in the field from paper pots, and budding them the second year when the stalk is about the size of a lead pencil. By this method the tap root is very little disturbed.

Seedlings of the carob, like those of most fruit trees, are unsatisfactory on account of their variability both in habits of growth and

in production. Since the trees are mostly dioecious, a large percentage of the seedlings will prove to be unfruitful males. Furthermore, seedlings are very slow coming into bearing and often the sex cannot be ascertained for several years. Budding or grafting, therefore, to a known good variety is advisable.

Fig. 4.—Individual flowers of the carob. No. 1, staminate flowers from a tree at Santa Barbara; No. 2, pistillate flowers from a different tree at Santa Barbara; No. 3, perfect flowers from a tree on the University Campus, Berkeley.

PLANTING

Since the long tap root of the seedlings makes it difficult to transplant carob trees successfully from the nursery row, the plants are commonly grown in pots or boxes from which they are moved into their permanent location. The carob is an excellent street and roadside tree as the foliage keeps bright and clean, the twigs seldom harbor injurious scale insects, and the trees thrive with a minimum of care and attention.

Since the carob bears the male and female flowers on different trees, it is necessary to have a few male trees in proximity to the

fruiting trees to provide for pollination which is effected both by wind and insects. A common practice in Europe is to bud or graft a staminate branch in each pistillate tree, thus insuring an abundance of pollen. In some cases a secondary male trunk or sprout is trained up into the center of the tree. The necessity of insuring sufficient pollen cannot be too strongly emphasized and it will probably be found well worth while to propagate desirable male trees for inter-

Fig. 5.—Perfect flowers of the carob. The flowers of the carob tree are in racemes borne in profusion on the older branches. The outgrowth of the racemes from the same places on the branch year after year results in wartlike excrescences which are especially conspicuous when the tree is not in bloom. The racemes shown in photograph bear both staminate and perfect flowers.

planting with the female trees. Some carob trees growing in southern California seem to be self-pollinating, the flowers being perfect. The most productive ones are being propagated and such trees should not require other male plants for the production of pollen.

Considerable success has been attained in Italy and other European countries by planting the carob on barren, unproductive hillsides. While it may be true that some otherwise unprofitable hillsides in California can be utilized by planting carob trees, we believe the value of the tree and its crop will justify the use of better land where it is available. Pasture or grain lands in the hills, or in the valleys where

there is not too much frost, can be made to produce an abundant forage of carob pods if the trees are given good care and attention during the first few years. Even alkali lands may be utilized, although in the interior valleys such situations are almost always frosty.

On hillsides the trees can best be set in terraces constructed on the contour. In good soil the trees grow to a large size and should be planted from 35 to 40 feet apart. Those who plant carob trees on wild unproductive lands must be prepared to fight gophers, which are fond of the roots, and squirrels, which will destroy the foliage and pods.

YIELD

As already stated seedling trees are slow coming into bearing. Buds placed in thrifty seedling trees should begin to produce three years after budding, although it will be six years before good crops may be expected. Various statements are made as to the productivity of the trees in other countries. According to Dr. Aaronsohn, a tree 25 to 30 years old yields about 450 to 550 pounds of pods annually. Wild stocks, 15 or 18 years after grafting, have yielded 900 to 1100 pounds in good years, although a good average is 450 pounds to the tree. Yields in the countries of southern Europe are variously reported from a few pounds up to 3000 pounds per tree.

In southern California bearing carob trees are frequent but accurate figures on the amount of pods produced are difficult to obtain. The following list, however, gives yields of some of the seedling trees:

Location	No. of trees	Age of tree, years	Yield per tree, pounds
Anaheim	1	20 to 25	400
Anaheim	5	19	20– 90
Santa Fe Springs	2	18	100–400
Hollywood	1	18	150–400
Pasadena	2	16 to 18	150–300
Rialto	1	15	200–400
Los Angeles	1	30	200

Several of the trees listed above are neglected, crowded in among other shrubs, or heavily pruned. Some trees have produced eight or ten grain sacks each in a season, a sackful of pods weighing from 45 to 50 pounds.

VARIETIES

As already stated, most of the leading varieties of carobs of southern Europe have been introduced for trial. Some of these are valuable for stock food but many are used for human consumption.

S. P. I. No. 7132* is described as being a poor yielder but the fruits are so full of sugar that drops of syrup run out when the pods are broken. No. 7461 is said to be one of the sweetest varieties known, being planted in Spain for table use especially, as it is too valuable for horse food.

Among the numerous seedling trees which have already fruited in California, some have been selected as superior in fruiting qualities, size and shape of pod, and especially in the sugar content. Nursery-

Fig. 6.—Seedling carobs are often grown in heavy paper pots until they are ready for setting in the nursery row or in the field. Seedlings may be set in the field in orchard form and budded to desirable varieties two or three years later.

men and intending planters are selecting desirable mother trees from which to propagate, and a few varieties have been named. Whether the California seedlings are as good as the varieties selected in other countries remains to be determined later when trees of the latter come into bearing.

* Referring to the numbers of the Division of Foreign Seed and Plant Introduction, Washington, D. C.

NUTRITIVE VALUE OF THE CAROB BEAN

By M. E. JAFFA and F. W. ALBRO

The Division of Nutrition has completed the analyses of a number of samples of carob beans, the results of which are presented herewith.

COMPOSITION OF CAROB BEAN

The carob bean consists of the pod and the seed, as indicated in Table I showing the results of the physical analyses of samples submitted. The dry beans vary in weight from 6.7 to 23.7 grams. The seed also varies greatly, as is shown by the figures 0.2, 2.7 and 1.2 grams for the minimum, maximum and average, respectively. The seed, on the average, represents 11 per cent of the entire weight of the bean, and the pods 89 per cent, the maximum and minimum figures respectively being 98 and 2.

The percentage composition of the whole bean, pods and seeds, is shown in Table II. This table is divided into three parts, showing the analysis of pods and seeds; of pods only, and of the seeds. Five separate analyses were made of the seed, the results indicated in part 3, the analyses of the corresponding pods being given in part 2. The composition of the pods and seeds, as detailed in part 1, was calculated from the analyses of the seeds and pods with the aid of the data in Table I.

The seeds are very hard and tough and unless crushed and broken could not, therefore, be utilized by the animals. The pod, however, is different, and the analysis, therefore, of the pod alone would more nearly represent the actual feeding value than does the analysis of the entire bean, that is, the pods and the seeds.

Furthermore, the percentage of the seeds in several varieties is extremely low, and in two instances (Nos. 2493, 2494), the lower percentage of seed is accompanied by the highest percentages of sugar.

The percentage of protein in the seeds ranges from 19.7 as a maximum to 14.4 as a minimum, with an average of 16.5. If the seeds were readily broken this protein would be of considerable value, but when the pods are not treated or so treated that the seed is not crushed, little, if any, of this protein would be made available. It would

appear, however, that the bean showing the highest percentage of protein in the seed corresponded to a pod comparatively low in sugar. On the other hand, it will be noticed that No. 2198 showing the highest percentage of protein in the seed, shows also next to the highest percentage of seed in the bean, namely, 17 per cent, so that the advisability of processing the pod so as to crush the seed is well indicated. Experimental data, however, are not at hand to show the availability of the nitrogen in the seed.

The average percentage of ash, 3.18, is only about three-fourths of the corresponding figure for the ash of ordinary beans (seeds), while the percentage of ether extract, 2.5, is about the same as that noted for California beans.

The crude fiber percentage averages 7.5, which is considerably higher than that indicated for the average bean. This relatively high percentage of crude fiber is due to a large proportion of hard "shell" covering the kernel.

The nitrogen-free extract constitutes more than 50 per cent of the total weight of the seed, the average being 58.61 per cent. There is no starch in the seed and very little sugar, the latter, including the gums, amounting to less than 6 per cent, according to investigations carried on by the Connecticut Agricultural Experiment Station. Fifty per cent of the total weights of the seed, therefore, consists of carbohydrate matter, other than starch, sugars, and gums. Such compounds, while having a feeding value, do not possess the high nutritive value of sugar or starch. It would, therefore, appear that the availability of the nitrogen-free extract in the case of the carob seed is much lower than that in food materials containing a large amount of starch.

In varieties of the carob bean where the seed constitutes but 2 per cent of the pod, the amount of available nutriment furnished by the seed would probably not amount to more than 1 per cent of the total weight of carob bean fed. It is not necessary to be so careful with such varieties in crushing the seed as it is where the percentage of seed amounts to 18 per cent of the total weight, as indicated in No. 2367, a variety grown by Mr. Beers, Santa Barbara.

The water content of the samples analyzed varies greatly, from a minimum of 3.7 to a maximum of 24.7, this difference being accounted for by the condition of the samples, some being submitted to the laboratory in a much drier condition than others.

The average ash content of the pods, 2.7 per cent, is not high, and does not differ materially from that of the grains and seeds, but rates much lower than do the pods of ordinary beans, which average 7.4

per cent ash. The carob pod rates low in protein, as evidenced by the figures, 2.02 per cent, for the minimum, 7.18 for the maximum, with an average of 4.5 for sixteen varieties. This figure corresponds quite closely to the average, 4.3 per cent, for protein content of a number of samples of California bean pods.

The amount of ether extract or fat varies greatly in the carob pods, the minimum percentage .22 is reported by the Connecticut Agricultural Experiment Station. The minimum for California varieties examined is .71, while the maximum is 4.02. These two minima, and also the low percentage, 0.80, found in No. 2974, bring down the average to 2.4, which compares very favorably with the fat content of ordinary bean seeds but is twice that noted for the common bean pod.

The carob pod owes its popularity and feeding value mainly to its content of sugar, which is present in both varying amounts and kinds. There are two sugars found in the carob pod, "invert" or reducing sugar, and "sucrose" or can sugar. There does not appear from the data reported any rule concerning the proportions of these two sugars present. In some instances, as in No. 2201, we find 20.5 per cent of reducing sugars and only 7 per cent of cane sugar, while in the number preceding, No. 2200, the quantities are practically reversed, being 6.88 for reducing sugars and 21.7 for sucrose. These two samples, perhaps, represent the extremes. In the majority of samples examined cane sugar predominates, with a maximum of 43.6 per cent. The amount of reducing sugar for this variety is 8.4; in other words, there is present a total of 52 per cent sugar. Of the seventeen samples analyzed six show 40 per cent and upwards of sugar, five 30 per cent and upwards; in other words, ten samples of the seventeen tested indicate over one-third of the total weight as available sugar. Three samples, Nos. 2201, 2371, and 2372, show a low percentage of sugar, the figures being 7.0, 8.9, and 7.5 respectively. These materially lower the average, which is for the seventeen varieties 23.2 per cent.

It will be seen from an inspection of the table that there are other carbohydrate compounds than sugar in the carob. The amount of such compounds varies from about 25 per cent as a minimum to upwards of 48 per cent as a maximum, averaging 36.3 per cent. The exact nature of these compounds is not known as no investigations have been carried on in this connection. Starch is present in the pods to the extent of about 1 per cent only, as indicated by the Connecticut investigation. Qualitative tests made on several samples in this laboratory apparently confirm the eastern finding.

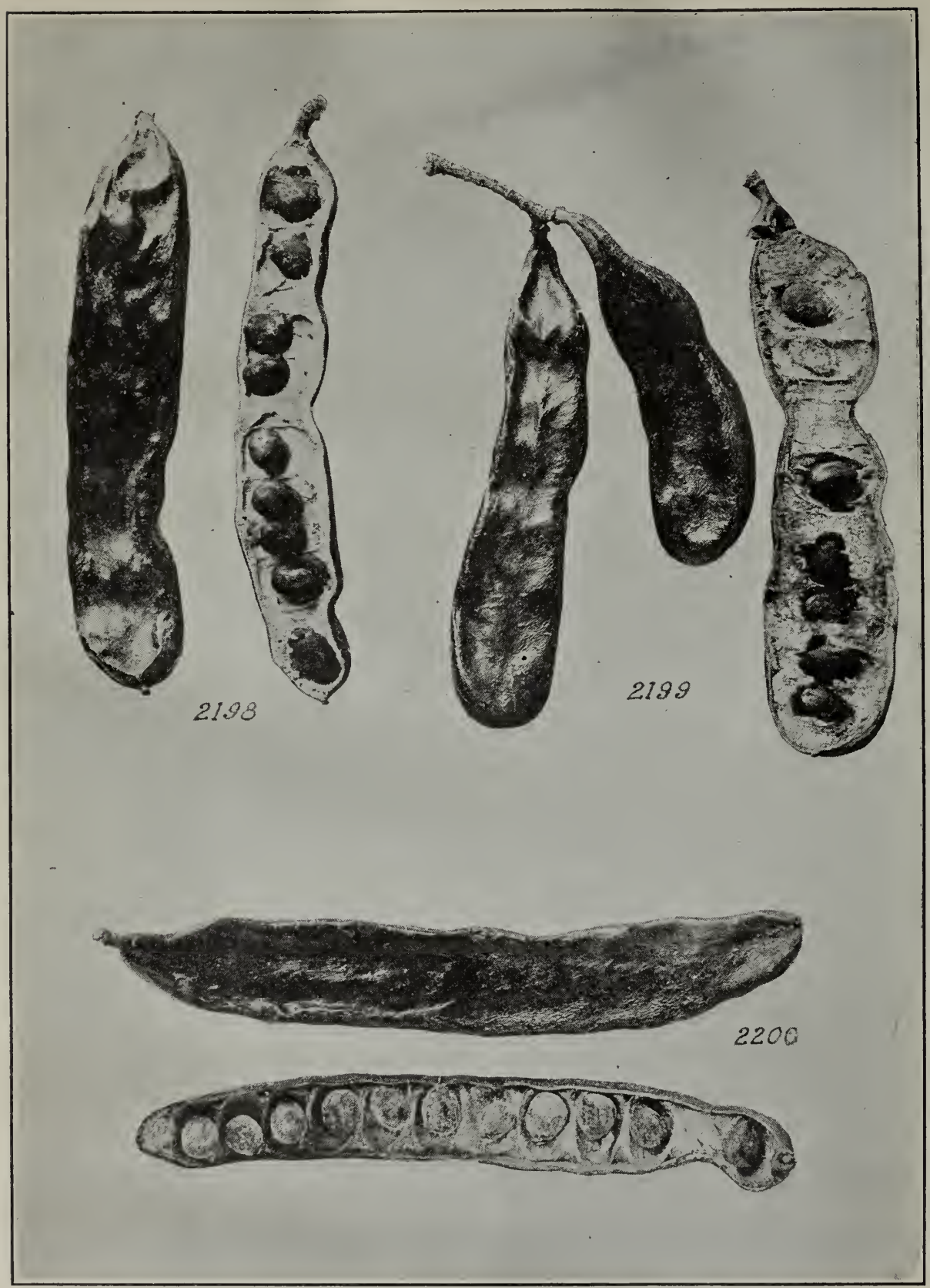

Fig. 7.—2198, carob bean from a perfect-flowered tree, Santa Barbara. An abundant bearer. Five-eighths natural size. 2199, carob bean from a very fruitful tree, Montecito. Five-eighths natural size. 2200, carob bean from Montecito. Five-eighths natural size.

The crude-fiber content, like that of other ingredients noted, is not constant for the different varieties even when reduced to a water-free basis. This is well indicated by the figures for the minimum, maximum, and average, which are 3.1, 15.3, and 8.8 per cent, respectively. As far as feeding purposes are concerned, that containing the least amount of crude fiber should be the most valuable, provided that the sugar content is also high. From the table it is seen that in this connection No. 2493 ranks the highest, with only 4.7 per cent of fiber and 53 per cent of sugar. In general it may be said that the highest fiber contents are associated with the lowest sugar percentage. This is shown by an examination of the figures recorded for Nos. 2371 and 2372, where the crude fiber is 13.6 and 15.3, while the corresponding sugar percentages are 21.9 and 20.7.

It has been stated that the carob bean contains tannin, which might render it undesirable as a feeding stuff for continued use. A careful examination made of a number of samples of the ripe carob pod fails, however, to justify such a statement. Only traces of tannin were found.

THE NUTRITIVE VALUE OF THE CAROB BEAN

The carob pods have been extensively used for a number of years in Europe as a feed for cattle and swine, also for horses, and to a limited extent, as a food for man. It is to be hoped that a larger use in this state will, in the near future, be made of this valuable feeding stuff. The most desirable form in which this could be utilized is that of a meal because in such a condition more nutriment will be rendered available to the animal from the seed than in any other way. The beans, however, as previously indicated, contain an appreciable percentage of gums which will clog the ordinary grinding machine. If, however, it were possible to break the beans and treat them with water, the treated product could be dried and then easily ground in the ordinary grinder. While such a process would require time and labor, it would in the end pay for such effort on account of the increased amount of nutriment rendered assimilable for the animal. It goes without saying that the water extract, rich in sugar, would not be thrown away, but used to moisten other roughage and thus render it more palatable and appetizing.

If, however, it would not be deemed feasible to adopt the foregoing suggestion, then, in order to get the best results, it would be necessary to treat the beans as one would grain when it is to be "rolled." In

this way the pods would be broken and the seeds more or less crushed, thus enabling the digestive juices of the animal to better attack the seeds. The large amount of sugar which some of these varieties contain renders it a very valuable food for fattening and has been

Fig. 8.—2201, carob bean from Pasadena. Five-eighths natural size. 2202, carob bean from Duarte, very rich in sugar. Five-eighths natural size.

so used in Europe, according to Potts. It must be remembered, however, that in order to get the best results with carob beans they should be fed with some material rich in protein, such as the oil cake meals, linseed, cocoanut, soy-bean, etc.

In view of the fact that sugar is such an excellent source for energy in the animal body, particularly when work is concerned, it can be readily understood how valuable is this carob bean for horses doing heavy work.

Any practical feeding of carob beans, when properly prepared, would take the place of some concentrate, such as grain, but with the exception of those varieties high in crude fiber, it should not be used to replace to any extent the roughage, for the reason that only about one-third of the samples examined show high crude fiber, the remaining low and varying in amount from that found in rolled barley to the quantity ordinarily recorded for bran. Just how much should be used would depend entirely upon local conditions, and the kind of animal being fed. For horses, as Pott states, as much as 6.6 pounds per day of carobs have been successfully used in connection with hay or other roughage.

For the cow it would be necessary when using this as a substitute for part of the grain to add more of the protein concentrate, because the carob pod is low in protein as compared with any of the mill by-products which are used, and successfully so, in the ration of the cow. The carob pods may also be advantageously incorporated in the ration for swine, but it would be best for such animals to so treat the carob that the seed is more or less crushed; the sugar in the carob lends itself admirably to the fattening of the animal.

Even if the carob could be reduced easily to a meal, it would not be advisable to use any large amount in the mash for a laying hen, because too much sugar will eventually decrease egg production. For growing pullets, on the other hand, the case is different and much more could be used.

Professor Woll at the University Farm at Davis, conducted a very successful experiment in feeding carob pods to calves; the object was to compare the nutritive value of carob pods with barley, for skim-milk calves. The trial was continued for thirteen weeks. The two lots were fed as follows:

Lot. 1. Carob pods and ground milo, 1:1 by weight.

Lot. 2. Ground barley and ground milo fed in the same proportion.

The calves received in addition to other foods, 0.4 of a pound per day of carob pods, while the control lot received, in addition to other foods, 0.35 of a pound ground barley. In other words, the .4 of a pound of carobs practically offset the .35 of a pound of ground barley. The average gains in body weight per day for Lot 1 were 1.81 lbs., for Lot 2, 1.7 lbs. The calves relished the pods greatly and, as a rule, ate them before the milo. The carob used in this experiment is represented by analysis No. 1704, Table II, part I. The foregoing emphasizes the nutritive value of the carob pod for growing calves.

The carob pod has been successfully used in the fattening of steers, and if conveniences are at hand, it is preferable to cook them, although satisfactory results are obtained otherwise.

Owing to the richness of the carob bean in sugar, it has been suggested that it could be utilized as human food. For such purposes those varieties should be selected which show the minimum amount of crude fiber because this ingredient is objectionable as far as human food is concerned. A sample of powdered carob pod prepared in New York City was submitted to the Nutrition Laboratory. Upon analysis the powder showed the following results:

TABLE I

	Per cent
Water	9.76
Ash	3.24
Protein	4.55
Fat	3.85
Fiber	7.12
Invert	6.68
Sucrose	34.65
Nitrogen-free extract other than sugar	30.15
	100.00

It is noticed that the total sugar percentage is upwards of 41, which is above the average for carob pods as recorded in Table II, part II. The fiber, however, is only slightly below the average for this ingredient. If this material were cooked with a cereal, sugar would not be required in addition thereto. Excellent use could be made of the powdered carob pod by those who need more roughage than that supplied by the ordinary diet.

TABLE II.—CHEMICAL ANALYSIS OF CAROB BEAN

I. Pods and Seeds

No.	Water	Ash	Protein	Ether Extract	Sugars Reducing	Sugars Sucrose	Nitrogen-free Extract*	Crude Fiber
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1704	11.91	1.67	7.96	1.00	12.94	13.96	44.96	5.60
2198	9.12	3.46	5.78	2.57	8.88	16.93	43.03	10.23
2199	11.30	1.95	6.15	3.82	11.64	8.77	45.70	10.67
2200	12.30	2.63	5.72	2.68	6.00	18.88	42.27	9.52
2201	17.68	2.38	4.38	2.79	18.69	6.39	39.56	8.13
2202	10.91	2.63	3.26	2.76	15.66	24.66	32.32	7.80
‡	19.81	2.61	15.22	1.37	11.59	24.51	43.57	17.42
§	14.05	3.26	5.57	.34	3.25	41.56†	26.99	4.98
Minimum	9.12	1.67	3.26	1.00	3.25	6.39	26.99	4.98
Maximum	19.81	3.46	15.22	3.82	18.69	41.56	43.57	17.42
Average	13.28	2.57	6.75	2.17	11.08	19.44	39.80	9.29

II. Pods

2198	8.93	3.44	3.33	2.58	10.44	19.92	40.80	10.56
2199	11.04	1.75	4.47	4.02	13.70	10.32	43.48	11.22
2200	12.27	2.50	3.77	2.64	6.88	21.70	40.28	9.96
2201	18.08	2.39	3.33	2.86	20.54	7.02	37.54	8.24
2202	11.14	2.55	2.02	2.76	17.40	27.40	28.96	7.77
2367	7.95	3.38	4.12	3.62	16.00	11.82	42.38	10.73
2368	16.00	2.48	4.47	1.43	14.44	17.45	35.31	8.42
2369	5.60	3.23	2.64	2.72	8.72	36.07	31.38	9.64
2370	8.04	2.96	6.65	3.37	18.92	11.37	37.14	11.55
2371	5.70	3.87	3.40	3.08	13.04	8.93	48.36	13.62
2372	3.70	3.30	7.00	2.78	13.20	7.53	47.18	15.31
2493	8.21	2.71	7.18	.71	8.36	43.62	24.48	4.73
2494	12.50	2.28	5.09	2.08	5.71	37.88	29.49	4.97
2727	7.50	2.41	5.00	2.13	11.76	30.89	37.17	3.14
2974	20.00	1.93	4.74	.80	5.37	33.08	28.08	6.00
2975	24.70	.....	.....	.....	3.00	28.23	.....	.....
§	14.15	3.25	4.81	.22	3.62	40.63†	28.52	4.80
Minimum	3.70	1.75	2.02	.22	3.00	7.02	24.48	3.14
Maximum	24.70	3.87	7.18	4.02	20.54	43.62	48.36	15.31
Average	11.50	2.72	4.50	2.37	11.24	23.17	36.30	8.78

* Nitrogen-free extract other than sugar.

† Including dextrines.

‡ Cal. Exp. Sta. Rept. 1903–04, p. 49.

§ Conn. Exp. Sta. Rept. 1899, p. 177.

TABLE II.—(*Continued*)

II. Pods, Calculated to Water-free Basis

No.	Ash	Protein	Ether Extract	Sugars		Nitrogen-free Extract*	Crude Fiber
				Reducing	Sucrose		
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
2198	3.77	3.66	2.83	11.46	21.88	44.80	11.60
2199	1.96	5.05	4.51	15.40	11.60	48.87	12.61
2200	2.84	4.32	3.00	7.84	24.75	45.90	11.35
2201	2.91	4.07	3.48	25.08	8.57	45.83	10.06
2202	2.86	2.27	3.11	19.58	30.85	32.59	8.74
2367	3.67	4.37	3.93	17.38	12.95	46.04	11.66
2368	2.95	5.32	1.70	17.19	20.78	42.04	10.02
2369	3.42	2.80	2.88	9.24	38.20	33.24	10.22
2370	3.21	7.23	3.66	20.62	12.38	40.43	12.47
2371	4.10	3.60	3.26	13.83	9.46	51.30	14.45
2372	3.42	7.27	2.88	13.71	7.82	49.00	15.90
2493	2.96	7.72	.78	9.12	47.56	26.69	5.17
2494	2.60	5.81	2.37	6.53	43.30	33.71	5.68
2727	2.60	5.40	2.30	12.72	33.40	40.18	3.40
2974	2.41	5.92	1.00	6.70	41.35	35.12	7.50
2975	.....	.....	.....	3.98	37.49	.....	.....
§	3.77	5.60	.26	4.20	47.32†	33.25	5.60
Minimum	1.96	2.27	.26	3.98	7.82	26.69	3.40
Maximum	4.10	7.72	4.51	25.07	47.56	51.30	15.90
Average	3.09	5.03	2.62	12.61	26.45	40.56	9.78

III. Seeds

No.	Water	Ash	Protein	Ether Extract	Nitrogen-free Extract	Crude Fiber
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
2198	10.20	3.60	19.69	2.51	55.66	8.34
2199	12.76	3.08	15.67	2.68	58.24	7.57
2200	12.11	3.49	19.08	3.06	55.36	6.90
2201	13.63	2.32	14.86	2.13	59.99	7.07
2202	8.89	3.36	14.44	2.78	62.54	7.99
§	12.84	3.27	15.00	1.83	59.90	7.16
Minimum	8.89	2.32	14.44	1.83	55.66	6.90
Maximum	13.63	3.60	19.69	3.06	62.54	8.34
Average	11.74	3.18	16.46	2.50	58.61	7.50

* Nitrogen-free extract other than sugar.

† Including dextrines.

§ Conn. Exp. Sta. Rept. 1899, p. 177.

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